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A STUDY ON MINIMISING REJECTION IN A MODEL GRINDING CELL

Dr. KANNAN. V[1] & SANGEETHA. P[2]

[1]*Professor, Department of Management Studies, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, India*

[2]*Assistant Professor, D J Academy for Managerial Excellence, Coimbatore, Tamil Nadu, India*

ABSTRACT

Zero defect management is an idea that gained its focus from 1960's. The philosophy was put together and proposed by Philip Crosby. It is a program to eliminate defects in industrial production, and was primarily intended for automobile production. Manufacturing processes tend to produce operational wastages due to various reasons, which can be reduced by identifying and eliminating those reasons. It has been a very challenging engineering problem particularly in multistage manufacturing, where maximum number of processes and activities are performed. The objective of this paper is to identify issues in model grinding cell and provide suggestions to achieve Zero Defects in Model Grinding Cell. The study was conducted in a manufacturing company. Primary data was collected by observation. Analysis was conducted for finding root cause using fishbone diagram. Suggestions were provided to achieve Zero Defects with the help of Pareto Analysis Diagram. With the help of Pareto diagrams, which are mostly used to identify critical areas, the manufacturing process defects in each stage of production have been prioritized by arranging them in decreasing order of importance. Then cause and effect diagram was applied to explore the possible causes/factors of defects and to determine the causes/factors, which has the greatest effect.

KEYWORDS: Zero Defect, Fishbone Diagram, Pareto Analysis & Automobile Production

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Original Article

INTRODUCTION

Root Cause Analysis

"Root Cause Analysis (RCA) is the process of identifying causal factors using a structured approach with techniques designed to provide a focus for identifying and resolving problems. Tools that assist groups or individuals in identifying the root causes of problems are known as root cause analysis tools. Every equipment failure happens for a number of reasons. There is a definite progression of actions and consequences that lead to a failure. Root Cause Analysis is a step-by-step method that leads to the discovery of faults or root cause. An RCA investigation traces the cause and effect trail from the end failure back to the root cause. It is much like a detective solving a crime. To meet up the high changing market demands along with high quality at comparable prices, one shall have to identify quickly the root causes of quality related problems by reviewing an event, with the goals of determining what has happened, why it has happened and what can be done to reduce the likelihood of recurrence".

Cause and Effect Diagram

"A cause and effect diagram, often called a **fishbone** diagram, can help in brainstorming to identify possible causes of a problem and in sorting ideas into useful categories. A fishbone diagram is a visual way to look at cause and effect. It is a more structured approach than some other tools available for brainstorming causes of a problem (e.g.,

the Five Whys tool). The problem or effect is displayed at the head or mouth of the fish. Possible contributing causes are listed on the smaller **bones** under various cause categories. A fishbone diagram can be helpful in identifying possible causes for a problem that might not otherwise be considered by directing the team to look at the categories and think of alternative causes. Include team members who have personal knowledge of the processes and systems involved in the problem or event to be investigated.

A fishbone diagram aims to break down and organize the Causes of an issue to reveal what elements have the greatest impact. Grouping the causes means you can think about the different elements of the problem as separate from the overall process. One or two of these "causes" will have a greater effect than the others and will guide you to the root of the problem".

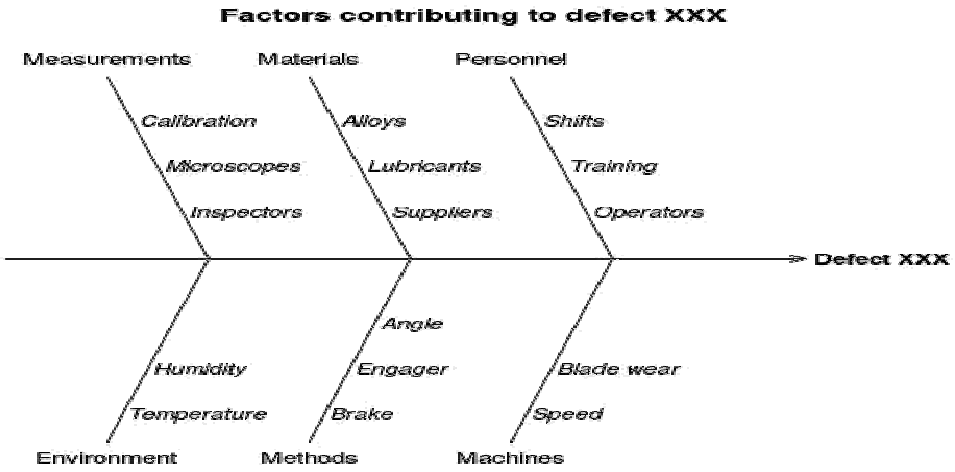

Figure 1: Cause and Effect Diagram.

"This structure also allows you to tackle smaller chunks which have a large impact on the problem. Looking at elements of the problem and not the whole process will likely make finding your solution less daunting and problem solving more manageable".

Zero Defect

Zero defect a term is coined by Mr. Philip Crosby in his book "Absolutes of Quality Management" is a management tool aimed at the reduction of defects through prevention. It is directed at motivating people to prevent mistakes by developing a constant, conscious desire to do their job right the first time.

"Zero Defects is a management tool aimed at the reduction of defects through prevention. It is directed at motivating people to prevent mistakes by developing a constant, conscious desire to do their job right the first time". "The idea of quality of the products was vested with the inspection team that they will not allow a faulty product reaches the customer. Before it reaches the end customer, the inspection is made and the product under question will be rejected if found faulty. But the concept of Zero defect management (ZD) shifted the entire focus from the inspection team to the worker. If a worker is not making any mistake, then the inspection team will not find any faulty product. This philosophy is having a very potential advantage that resource expenditure on a faulty product is avoided. The idea proposed that the worker should be convinced that, he is not doing an ordinary job. Instead he is doing a job that has very far implications than he thinks".

Pareto Analysis

"Pareto Analysis is a statistical technique in decision-making used for the selection of a limited number of tasks that produce significant overall effect. It uses the Pareto Principle (also known as the 80/20 rule) the idea that by doing 20% of the work you can generate 80% of the benefit of doing the entire job. Take quality improvement, for example, a vast majority of problems (80%) are produced by a few key causes (20%). This technique is also called the vital few and the trivial many".

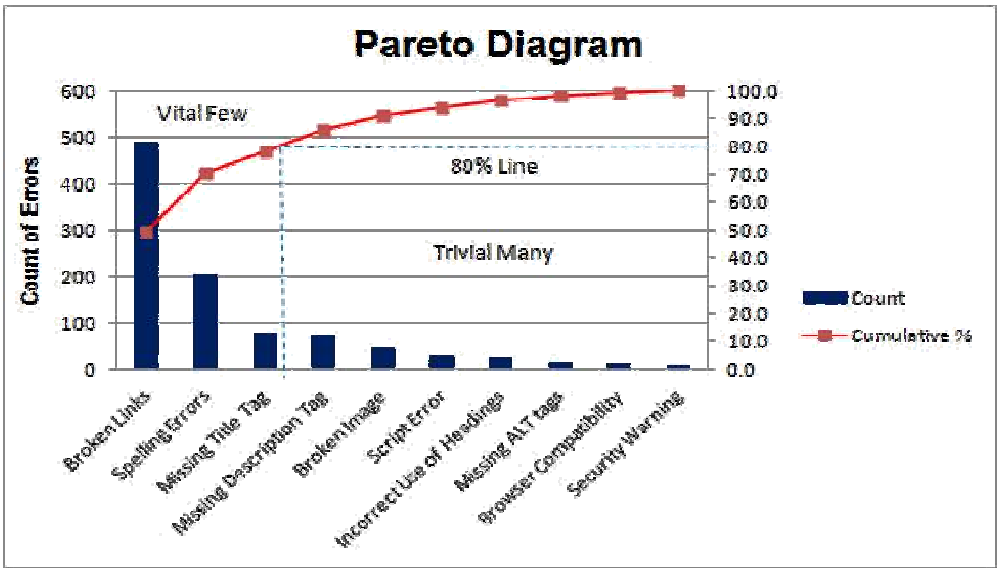

Figure 2: Pareto Analysis Chart.

"The 80/20 rule can be applied to almost anything:

- 80% of customer complaints arise from 20% of your products and services.
- 80% of delays in the schedule result from 20% of the possible causes of the delays.
- 20% of your products and services account for 80% of your profit.
- 20% of your sales force produces 80% of your company revenues.
- 20% of a systems defects cause 80% of its problems".

OBJECTIVES OF THE STUDY

Primary Objective

- To study the Root cause analysis and provide suggestions to achieve Zero defect in a model grinding cell.

Secondary Objectives

- To study the impact of Zero-defect implementation in reducing rejection rate.
- To study the improvement in productivity while practicing the Root Cause analysis.
- To analyze and suggest the scope of implementation of Zero defect in various process.

RESEARCH METHODOLOGY

"Exploratory research type is usually conducted to study a problem that has not been clearly defined yet. Conducted in order to determine the nature of the problem, exploratory research is not intended to provide conclusive evidence, but help

us to have a better understanding of the problem. Primary data was collected from the respondents through Observation by researcher. Secondary data was collected from websites, magazines and company profiles and through company websites. Work Sampling which was pioneered by L.H.C Tippet in a British Textile Mill was adopted for the study. It is defined as 'A technique in which a statistically competent number of instantaneous observations are taken, over a period of time, of a group of machines, process or workers. Each observation records that what is seen to happen and the percentage of observations recorded for a particular activity or delay is a measure of percentage time observed by the occurrence'. It is a method of finding the percentage occurrence of certain activity by statistical sampling and random observations. It is also known as 'Activity Sampling', 'Ratio-Delay Study', 'Random observation method', 'Snap-reading method', and 'Observation ratio study'".

DATA ANALYSIS & INTERPRETATION

Problem Statement

Last Six Months data shows that the maximum rate of rejection is 18% and minimum rate of rejection is 2.7% for model grinding cell and the average rate of rejection is 21.6% for the Machine name **M1495-DONABAT**. By reducing rate of rejection from 18% to 0% it would impact the long term business planning with the existing client and contribute to reduce process penalty.

Goal Statement

To reduce rejection rate from 18% to 0% at model grinding cell.

Check sheet:

Table 1: Cylindrical Grinding Model Cell Scrap Details(Dec'17-jun'18)

Sl. No	Defects	Cylindrical Grinding			Bore Grinding		Total
		M1821	M1495	M0862	M1834	M1665	
1	OD Minus	IIIII		IIIII IIIII			
		IIIII	IIII IIIII	IIIII IIIII			50
		IIIII		IIIII			
2	ID Plus				IIIII II	I	8
3	Ovality		I			I	2
4	Runout/Faceout		I	II	I		4
5	Centre problem	I					1
6	Damaged	I	I				2
	Total	**17**	**13**	**27**	**8**	**2**	**67**

Interpretation

Initially the grinding process in model grinding cell with respect to five machines was observed. With the help of checksheet it was inferred that majority of scrap occurs only through Outer diameter minus problem in all machines. Following that Inner diameter plus, Center problem, Ovality, Runout and faceout are observed.

Table 2: Pareto Analysis for Modern Grinding Cell

Machine Name	Machine no	Total no of Defects	Percentage %	Cumulative Percentage Value
G22 Cyl Grinding	**M0862**	27	40.30	40.30
Toyoda	**M1821**	17	25.37	65.67
Danobat	**M1495**	13	19.40	85.07
Toyo	**M1834**	8	11.94	97.01
Over beck	**M1665**	2	2.99	100
	Total	**67**		

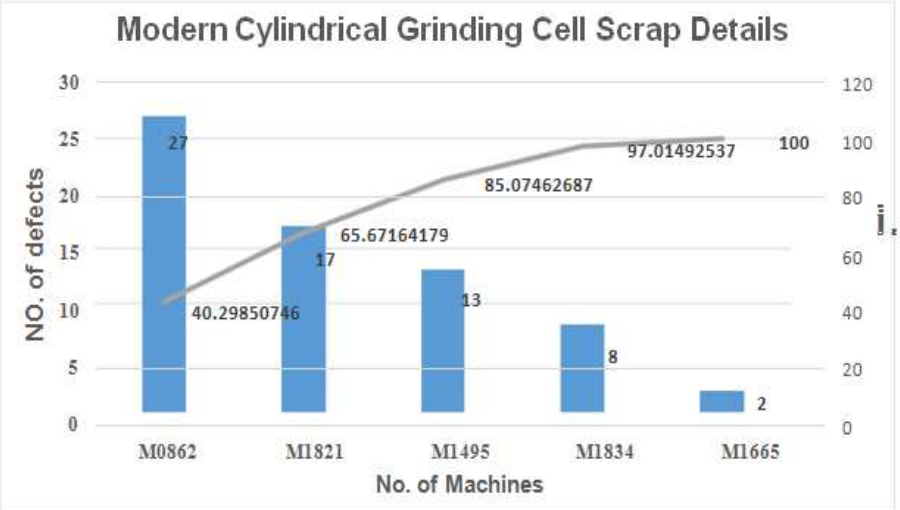

Chart: 1 Pareto Analysis.

Interpretation

Scoring (percentage) for the problems of each machine using Pareto Analysis which is shown in figure was done. From this figure it is inferred that 80% of defects is caused in G22 CYL Grinding, Toyoda and Danabat machines, remaining 20% of defects caused in toyo and over beck machines respectively.

Table 3: COPQ (Cost of Poor Quality) Calculation

Sl. No	Details	Counts
1	Number of pieces rejected last 10 months (for the parts numbers identified for study)	34
2	Number of pieces scrapped last 10 months	34
3	Scrap cost/piece	Rs.1017.33
4	Total Scrap Cost for Last 10 months	Rs.30170.24

Interpretation

This table shows that from last 10 months 34 pieces were scraped which amounts to Rs.30170.24. which also affects the operational cost and revenue of the company.

Table 4: Data Collection Plan

KPI	Operational Definition	Defect Def	Performance std	Specification Limit		Opportunity
				LSL	USL	
To reduce the rate of rejection of OD Minus	OD Minus observed on Brush shaft during grinding process which is dissatisfied the customer	OD Minus observed on Brush shaft is defective	In visual inspection OD Minus should not be observed on Brush shaft	2.7%	18%	To reduce the rate of rejection from 18% to zero

Interpretation

It is inferred from the table that the Key Performance Indicator is used to reduce the rate of rejection of outer diameter minus. The Outer Diameter defect ranges from lower specification limit of 2.7% to 18% of upper specification limits.

CTQ Tree

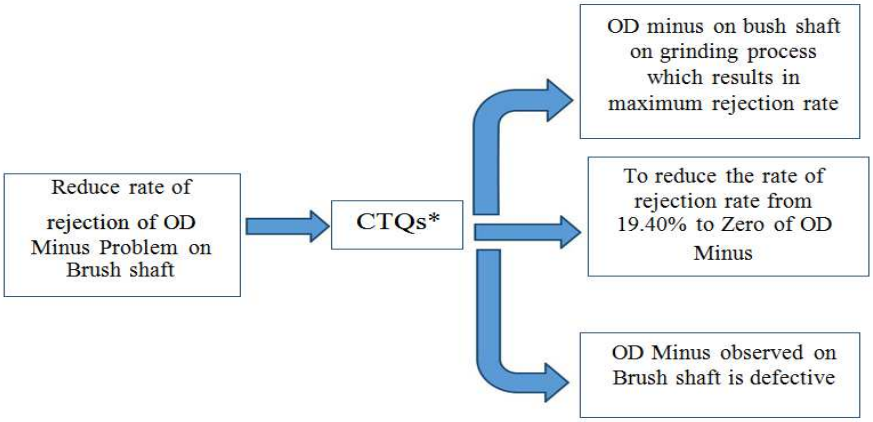

Figure 4: Critical to Quality Tree.

Interpretation

With the help of Critical to quality tree, the key measurable characteristics of a product or process whose performance standards or specification limits must be met in order to satisfy the customers are identified.

By inspecting the Geometric condition of danobat machine, machine standard specification before and after audit are noted are shown as follows:

Table 5: Machine Geometric Condition Audit Findings

Sl. No.	Geometric Parameter	Machine Specification	Actual	
			Before	After
1	Spindle run out	5 microns	5 microns	
2	Work head parallelism – Horizontal	0.008µm(300mm)	0.01µ (300mm length)	
3	Work head parallelism – Vertical	0.008µm(300mm)	0.01µ (300mm length)	
4	Bed Leveling – Z axis	0.020mm/m	0.1	0.02
5	Bed Leveling – X axis	0.020mm/m	0.05	0.02
6	Bed flatness – Z axis	0.003µm(300mm) & 0.015µm(1000mm)	0.02	0.02
7	Bed flatness – X axis	0.040µm(200mm)	0.02	0.02
8	Repeatability	0.0024mm	1 to 2µm for (20 times)	
9	Response		Machine x-axis movement is erratic for less than 50µm movement, movement error observed up to 6µm	

Process Parameter Audit Findings

Machine no: M1495

Machine name: Danobat CNC Cylindrical Grinding Machine

Table 6: Process Parameter Audit Findings

Sl. No.	Process Parameter	Standard	Observed	Conclusion
1	Grinding wheel speed RPM	1500rpm	1470rpm	Ok
2	Work head speed (rpm)	30-1000rpm	150rpm	Ok
3	Marpass size control	[+/-1] micron	1µm	Ok

Interpretation

After geometric condition audit, the process parameter audit is done in that machine to check the following parameters like Grinding wheel speed, Work head speed and Marpass Size control. The values are noted, and the observed values are within the standard limits are shown in table.

Table 7: Danobat Cylindrical Grinding Scrap Details

Issue Type	M1495	Percentage (%)	Cumulative Percentage Value
OD minus	15	44.11764706	44.11764706
Thickness minus	8	23.52941176	67.64705882
OD Damaged	3	8.823529412	76.47058824
Runout Problem	2	5.882352941	82.35294118
OD Ovality	2	5.882352941	88.23529412
Length minus	2	5.882352941	94.11764706
Length Plus	1	2.941176471	97.05882353
Grinding Crack	1	2.941176471	100
TOTAL	34		

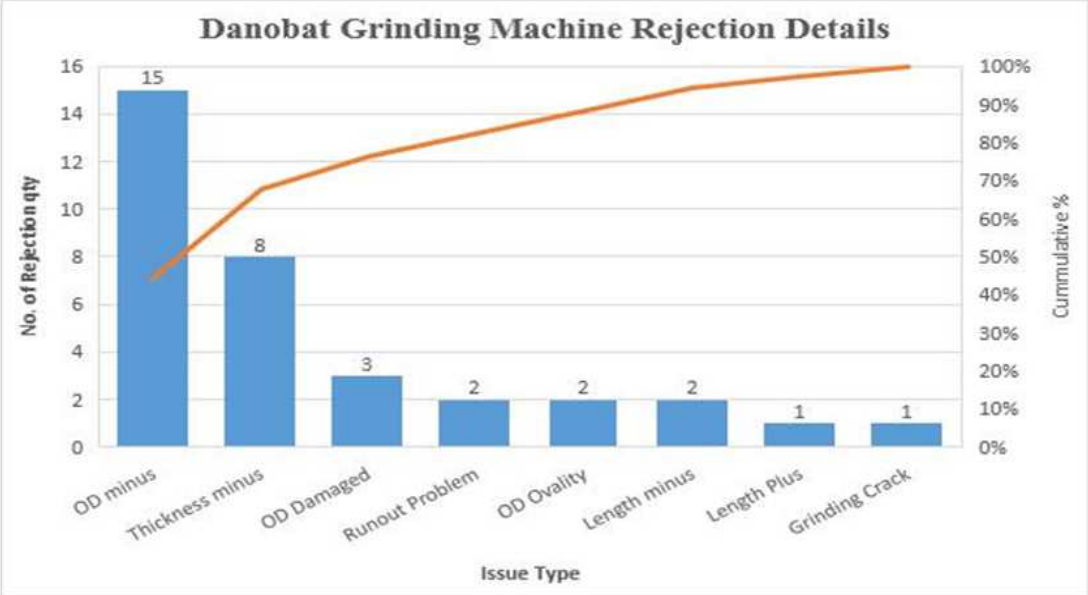

Chart 2: Pareto Diagram.

Interpretation

By collecting the last ten Months scrap details of Danobat machine, using Pareto Analysis, it was found that od minus, thickness minus and od damaged contributes 80% defects and runout problem, OD ovality, length minus, length plus and grinding crack 20% defects respectively are shown.

Chart: 3 Rejection Trend for (Last 10 months)

Note: Rejection trend of danobat machine istaken during the month of Aug'17 toMay'18

Chart 3: Rejection Trend for (Last 10 months)

COPIS

COPIS is a process improvement tool that summarizes the inputs and outputs of one or more processes in table form. The term COPIS stands for Customer, Output, Process, Input and Suppliers which forms the columns of the table are shown in the figure.

COPIS

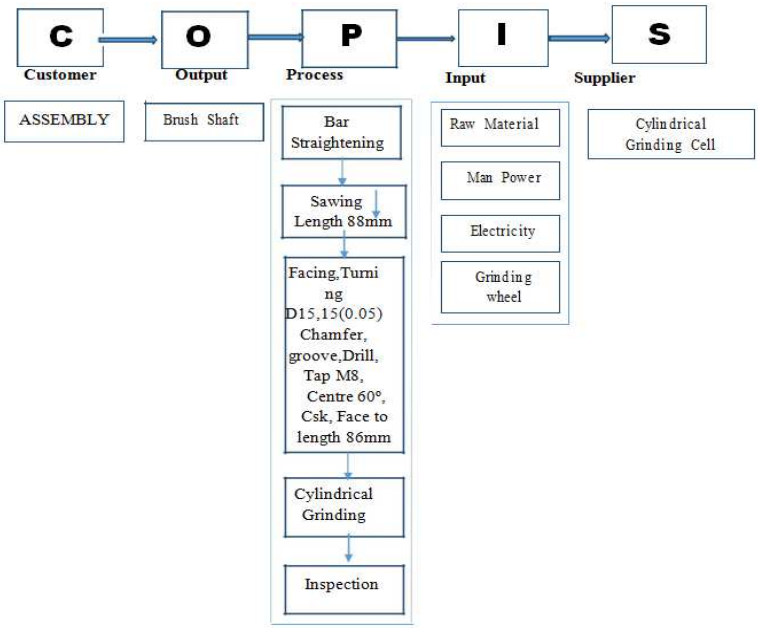

Figure 5: Copis Flow Diagram.

Interpretation

The Process flow of bush shaft are shown in the chart. Initially shaft material are bar straightened with level balancing, followed by sawing the rod to 88mm length followed by facing, turning D15,15(0.05), chamfer, groove, drill tap M8, Centre 60º csk, face to length 86mm, then fine grinding its surface and finally quality check inspection is carried out..

Cause and Effect (Potential Cause)

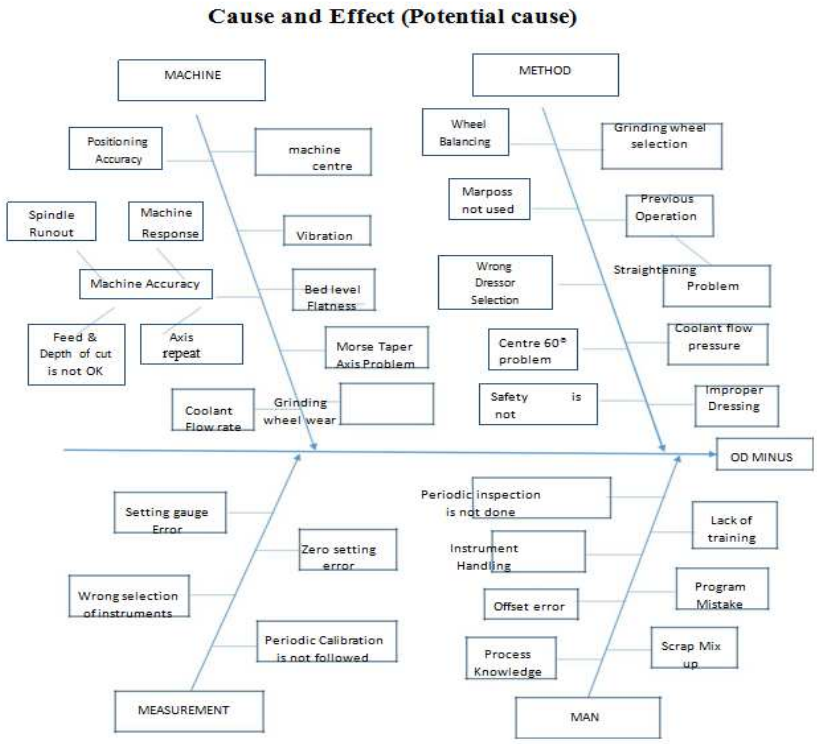

Figure 6: Potential Causes of Cause and Effect.

Interpretation

"A cause and effect diagram, also called as **fish bone** diagram, can help in brainstorming to identify possible causes of a problem and in sorting ideas into useful categories. The potential causes for defects occurs at 5M's are,**(**Machine, Method, Measurement, Man, Material)".

Cause and Effect (Vital causes)

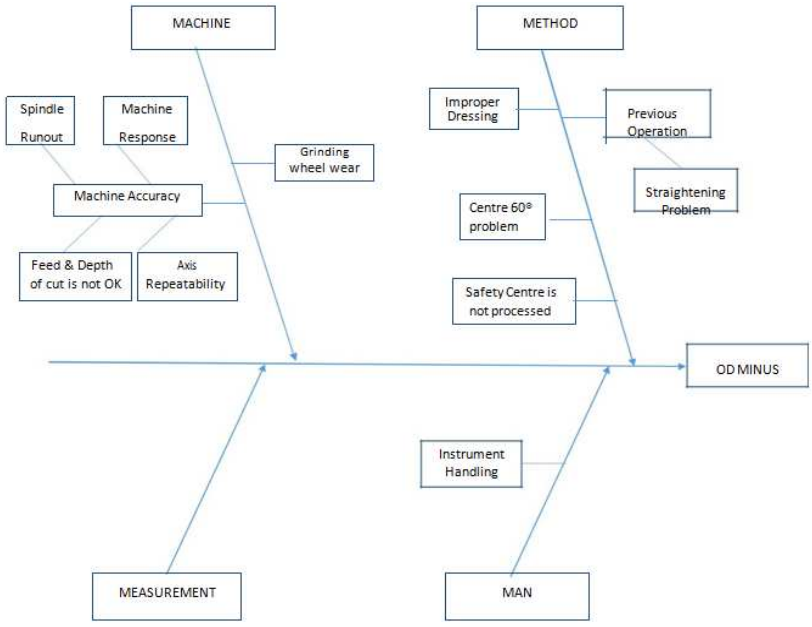

Figure 7: Vital Causes of Cause and Effect.

Table 8: Vital X's that are Impacting the (OD Minus) in Brush Shaft

Sl. No.	Problem	Data	Status
1	Feed rate	• Roughing F1 =0.10µm • Finishing F2 =0.05µm • Micro Finishing F3 =0.03µm	Ok
2	Material removal rate	For Allowance (0.355µm) • S1=0.330µm, • S2=0.150µm, • S3=0.010µm	Ok
3	Machine accuracy	Shown in Machine Geometric Details	Not ok
4	Centre problem	Component Centre ensured with Bluepaste Test	Ok
5	Safety Centre problem	Visually checked	Ok
6	Straightening issue	Not necessary for brush shaft length is 120µm, Generally Straightening operation is done for the shaft whose length more than 200mm	Ok
7	Improper dressing	Single point cutting tool used with depth of cut is 30µm. Dressing for every 5 pieces	Ok
8	Instrument handling	Visually checked	Ok
9	Grinding wheel wear	Grinding Wheel are made of Carborundom material, while dressing (30µm) depth of cut taken for everypass	Ok

FINDINGS

- **Machine Accuracy:** Poor accuracy of machining due to lack of machine response, spindle runout, feed and depth of cut is not ok
- **Grinding wheel wear:** Quick wearing of grinding wheel happens due to continuous processing of hardened materials.
- **Improper dressing:** Every five pieces once, proper dressing of grinding wheel is not done and it causes the OD Minus defect.
- **Centre 60º problem:** Component Centre is (+/-) 60º due to improper clamping.
- **Previous operation:** Ovality in component due to previous straightening process causes defects.
- **Instrument Handling:** Operators use wrong measuring instruments which leads to inaccuracy.

SUGGESTIONS

- The effectiveness of the implementation of zero defect was 100%. There was no rework or rejections after that. If pareto analysis and cause & effect are utilized better, than any other tools, rejections can be eliminated effectively. Operators have to use cause and effect method to avoid the major errors. So steps should be taken to ensure that they use it strictly.
- By fixing a linear scale in grinding wheel it will reduce outer diameter minus problem thereby improve the machine accuracy to achieve zero defect in grinding cell.
- The component centre ensured with blue paste test would reduce the centre problem.
- Single point cutting tool has to be used with a depth of cut of 30µm and dressing for every 5 pieces has to be carried out to address the improper dressing issues.

- Grinding Wheels of reputed makes have to be used to reduce the grinding wheel wear.

CONCLUSIONS

Pareto principle and CED have been utilized to recognize and rate various flaws and triggers. Based on Pareto analysis, insignificant and crucial flaws were also identified. Thus more importance ought to be given to those critical few flaws and also the root causes of those flaws. As stated by the root cause, the corrective procedure is advocated so as to cut the flaws to lessen the rejection prices. The analysis had been conducted to determine the main cause for a variety of flaws in version grinding mobile. Within this analysis, the diagnosis of these issues or root causes is limited to a particular phases of manufacturing. So CED may likewise be utilized for each single step of fabricating to boost product quality and endurance. CED is quite helpful in discovering the look of abnormalities of this procedure in the kind of excessive versions of procedure parameters, however they're not able to indicate the sources for the irregularities. It's well worth noting that this procedure totally eradicates the significant flaws and doesn't clarify the abrupt behaviour of those flaws. It's important to conduct Additional analysis on Several Other flaws, less regular defects to enhance productivity and quality by reducing rejection levels in particular manufacturing regions.

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AUTHOR'S PROFILE

Dr. P. Sangeetha BE.(ECE), MBA., Ph.D(HR)., UGC NET is working as Associate Professor at D J Academy for Managerial Excellence since 2008. She has over 13 years of academic experience. Her doctoral degree is in the field of Human Resource from Bharathiar University. She has handled papers like Operations Management, Advanced Production Management, TQM, Integrated Materials Management, Supply Chain Management, Performance Management etc., She has published many research papers in Journals and has presented papers in various International and National conferences. She has organized various FDPs and Conferences. She has acted as resource person for various MDPs organized at various institutes. She is an active member in various associations like Coimbatore Management Association, National Institute of Personnel Management, Society of Operations Management and Coimbatore Productivity Council. She has a passion for teaching and loves to experiment with different methods of meeting her classes and sincerely believes that knowledge is co-created inside the class room.

Dr. V. Kannan, BE (Mech.), MBA, Ph.D., Professor (Operations) in the Department of Management Studies at Kumaraguru College of Technology has over a decade of entrepreneurial experience besides working in industries of repute such as Pricol, Coimbatore and Grindwell Norton, Bangalore in the product development area. In the realm of academics, he has more than a decade of teaching experience handling subjects like Operations Management, Production Planning & Control, Advanced Production Management, Supply Chain Management and Business Process Reengineering at renowned management institutes. He has organised training programs, conducted MDP's and has been the resource person for conferences and seminars organised by academic institutions of repute. He is an active member in various associations like Institution of Engineers (India), Institute of Standards Engineers to name a few.